MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2017/2018**

## EEN3096 – COMMUNICATION ELECTRONICS

( TE / RE )

9 MARCH 2018
9.00 a.m - 11.00 a.m
( 2 Hours )

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**INSTRUCTIONS TO STUDENTS**

1. This Question paper consists of 6 pages excluding cover page with 4 Questions only.

2. Attempt **ALL FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Fig. Q1a shows an T-attenuator. Determine $R_1$ and $R_2$ in terms of the voltage divider ratio $K$ and $R_L$. Hint: $K = V_{in}/V_{out}$ .

[13 marks]

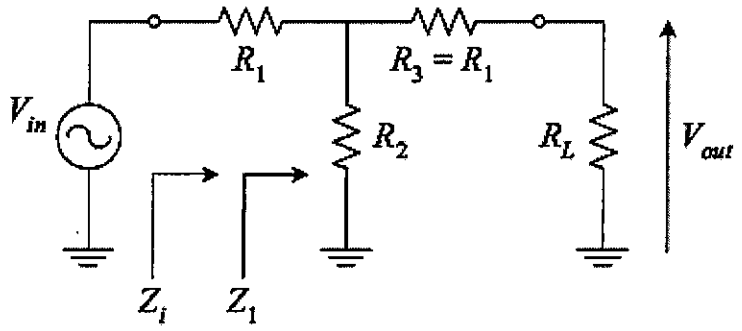


**Fig. Q1a**

(b) (i) Define the term "Quality Factor" in electronic circuits. [2 marks]

(ii) Compare a circuit with larger "Quality factor" to a circuit with smaller "Quality factor" in terms of its energy stored and loss.

[2 marks]

(c) Design an L-matching network for the circuit in Fig. Q1b to match a 1kΩ source with a 50Ω load at 5 x $10^6$ rad/s.

[8 marks]

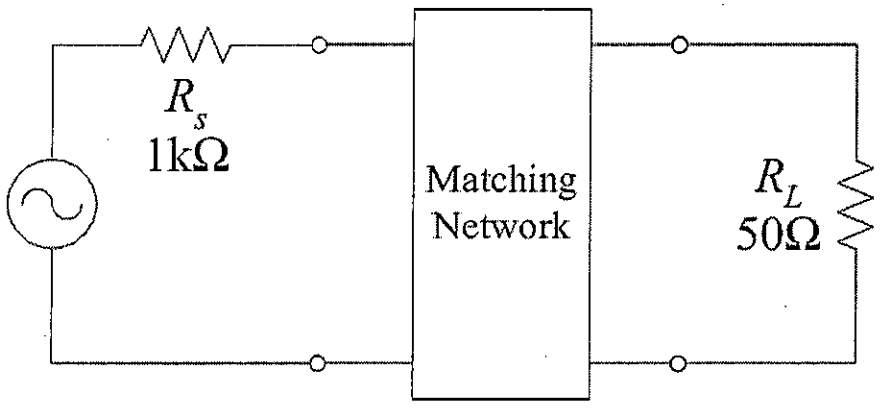


**Fig. Q1b** **Continued .....**

Question 2

(a) List down THREE ADVANTAGES of Tuned amplifier over Un-tuned amplifier. [3 marks]

(b) Consider the circuit of Figure Q2. At $I_C$ between 3.3mA and 5 mA, the transistor 2N3904 has the following parameters: $r_{bb}$ = 30 Ω, $h_{fe}$ = 230, $V_A$ = 50V, $C_c$ = 3.68 pF, $f_T$ = 270 MHz.

(i) Perform a DC analysis to determine the collector current $I_C$. [3 marks]

(ii) Draw the hybrid-$\pi$ model of the circuit with Miller's capacitance. [5 marks]

(iii) Determine the value of all elements in the model drawn in part (ii). [7 marks]

(iv) Determine the resonant frequency, $f_o$ of the $LC$ network. [2 marks]

(v) Determine the voltage gain $A_V$ (in dB) of the amplifier. [3 marks]

(vi) Determine the bandwidth at resonance. [2 marks]

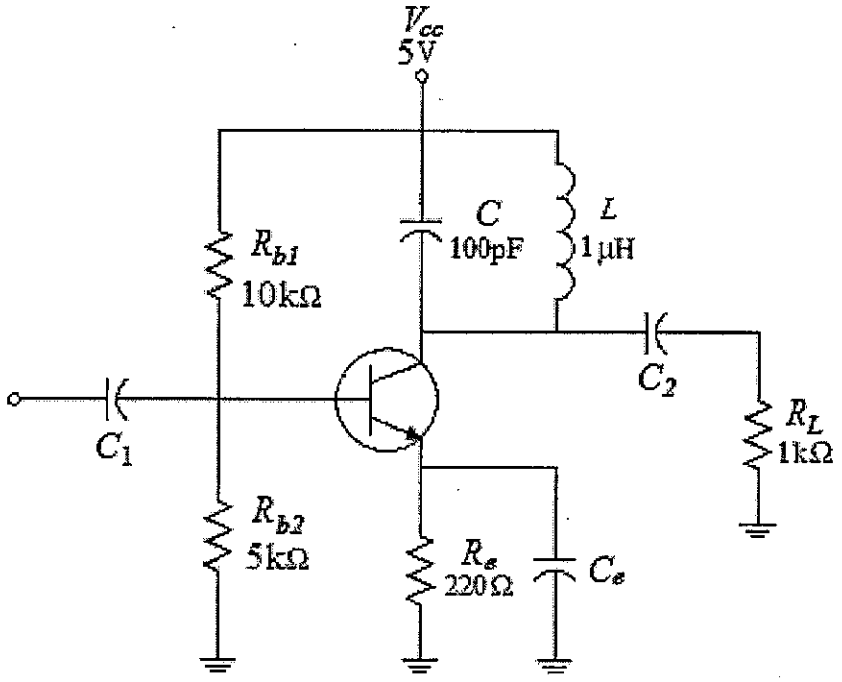


**Fig. Q2**

**Continued .....**

Question 3

(a) Sketch the block diagram of a Phase Locked Loop (PLL) and briefly explain the functions for each components of the PLL. [4 + 4 marks]

(b) Frequency Modulation, which is denoted as "FM" is commonly used in radio broadcasting systems. It refers to modulation of a waveform by the frequency during transmission. Explain how a PLL circuit could be used to "demodulate" the output of an FM radio transmission in order to extract the original audio signal from the received RF waveform. [7 marks]

(c) The system shown in Fig. Q3 is used to select different channels for a super-heterodyne communication. Determine the following:

(i) $f_{ref}$ [2 marks]

(ii) N for the receiver to tune to a channel centered at frequency 121 MHz. [3 marks]

(iii) The resolution (the minimum difference in frequency between two adjacent channels) of the receiver. [3 marks]

(iv) The loop gain ($k_L$) of the PLL when tuned to 121MHz. [2 marks]

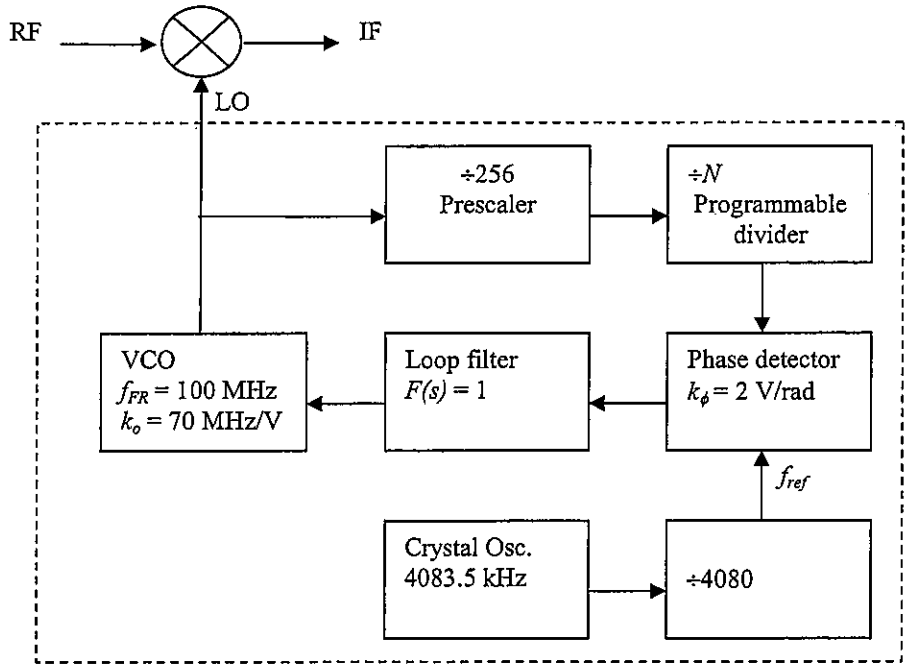


**Fig. Q3**

**Continued .....**

Question 4

(a) Name the TV broadcasting standards used in Malaysia together with their corresponding RF bandwidth. Give the full name of the acronym for the standards.

[5 marks]

(b) Sketch the block diagram of a Black & White TV receiver.

[10 marks]

(c) Sketch the block diagram of a Phase-Locked Loop Synthesized channel selection system.

[10 marks]

**Continued .....**

Appendix – Useful Formulas

**1. L impedance matching network (when $R_L > R_S$):**

$$B = \frac{X_L \pm \sqrt{R_L / R_s}\sqrt{R_L^{\,2} + X_L^{\,2} - R_s R_L}}{R_L^{\,2} + X_L^{\,2}} \qquad X = \frac{1}{B} + \frac{X_L R_s}{R_L} - \frac{R_s}{B R_L}$$

$$Q = \frac{|X|}{R_S}$$

**2. L impedance matching network (when $R_L < R_S$):**

$$B = \pm\frac{\sqrt{(R_s - R_L)/R_L}}{R_s} \qquad X = \pm\sqrt{R_L(R_s - R_L)} - X_L \qquad Q = R_S|B|$$

**3. π impedance matching network:**

$$L = L_1 + L_2 = \frac{R_I}{\omega_o}\left(\sqrt{R_S/R_I - 1} + \sqrt{R_L/R_I - 1}\right)$$

$$C_1 = \frac{1}{\omega_o R_S}\sqrt{\frac{R_S}{R_I} - 1} \qquad C_2 = \frac{1}{\omega_o R_L}\sqrt{\frac{R_L}{R_I} - 1} \qquad Q = \sqrt{\frac{R_S}{R_I} - 1} + \sqrt{\frac{R_L}{R_I} - 1}$$

**4. RF Class A transistor amplifier (Hybrid π model of BJT)**

| | |
|---|---|
| $r_{bb'}$ | **The base-spreading resistance.** |
| $g_m$ | **The transconductance.** $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C(\text{in mA})}{25.875mV}$ at T=300K, q= electronic charge, $1.6\text{x}10^{-19}$C |
| $C_e$ | **The emitter capacitance.** |
| $r_{b'e}$ | **The input resistance.** $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$ |
| $r_{b'c}$ | **The collector to base resistance.** $r_{b'c} = h_{fe} r_{ce}$ |
| $C_C$ | **The collector capacitance.** |
| $r_{ce}$ | **The output resistance.** $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where $V_A$ is known as the Early voltage and $I_C$ is the dc collector current. |

**Continued .....**

**5. High frequency Class A amplifier parameters:**

**(a) Voltage gain:**

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} << r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

**(b) Effective voltage gain (including the effect of source impedance $R_S$):**

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_s + r_{bb'}) << r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and $C_M$ = Miller capacitance $C_M = (1 + g_m R_o) C_C$

**(c) Transition frequency**

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

**(d) Input impedance**

$$Z_I = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$

**End of Paper**